

REMARKS

Applicants amend claims 1, 16, 29, 34, 50, 54, 70, 92, and 95.

Claims 1-4, 14, 54-57, 66, 70-73, and 82 stand rejected under 35 U.S.C. § 102(c) as being unpatentable over U.S. Patent 6,277,733 (Smith). Applicants respectfully traverse this rejection.

Claim 1, as amended, defines a method for removing polymer etch residue and recites, in part, “contacting said opening with a plasma to remove said polymer etch residue, said plasma generated from a gas consisting of ammonia.” (emphasis added). Smith does not disclose this method.

The Smith reference presents much discussion of use of hydrogen containing plasmas for etching during various stages of semiconductor processing, as illustrated in Figure 1. Figure 1 of Smith lays out a specific procedure of processing, which is explained in the text of the detailed description. Only two stages of the Smith process are directed to residue removal, i.e., stages 304 and 313, with only stage 313 being explicitly for residue removal (which is expressly recited in claim 1). The plasma disclosed by Smith for use with stage 304 is a “hydrogen-containing plasma” (column 3, lines 41-42), but besides hydrogen the plasma may also contain N₂, Ar, deuterium, NH₃, N₂H₂, H₂S, CH₄, or deuterated forms of these gases (column 3, lines 50-54). Such a plasma would not consist of ammonia as recited in the claim. The plasma disclosed by Smith for use with stage 313 is “a plasma which contains H₂ (deuterium or a hydrogen-containing gas, such as ammonia, can be used in place of H₂) and CF₄, (or other fluorocarbon, such as C₂F₆, CHF₃, CH₂F₂ or other fluorine-containing hydrocarbon . . .” (column 4, lines 28 and 34-38; emphasis added). Further, Smith explains that in this same step, i.e., 313, “[a] fluorinated hydrogen or hydrogen containing plasma is used to remove polymer/residues” when metal is present (column 4, lines 56-57; emphasis added). Again, these are not plasmas consisting of ammonia as recited in the claim. Nowhere else does Smith disclose

any processing step for removal of polymer etch residue and, in fact, most other references to plasmas by Smith require a combination of gases and none of the disclosed plasmas of Smith consist essentially of ammonia. Since Smith does not disclose the recited plasma for the recited processing step, Smith does not anticipate claim 1.

Since Smith does not disclose the method of claim 1, this independent claim and dependent claims 2-4 and 14 are patentable thereover. Applicants respectfully request that the 35 U.S.C. § 102(e) rejection of claims 1-4 and 14 be withdrawn.

Claim 54, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, “contacting said opening with a plasma to remove said polymer etch residue; said plasma generated from a gas consisting of hydrogen gas” (emphasis added). Such a method is not disclosed by Smith. For the same reasons Smith does not disclose a plasma for removing etch residue that consists of ammonia, likewise Smith does not disclose such a plasma that consists of hydrogen gas, as recited in the claim. If other gases can or should be added to hydrogen plasma according to Smith, then that plasma does not only consist of hydrogen gas. Thus, for the same reasoning set forth above for the patentability of claim 1 over Smith, independent claim 54 and dependent claims 55-57 and 66 are likewise patentable thereover. Applicants respectfully request that the 35 U.S.C. § 102(e) rejection of claims 55-57 and 66 be withdrawn.

Claim 70, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, “contacting said opening with a plasma to remove said polymer etch residue; said plasma generated from a gas consisting of methane gas.” For the same reasons Smith does not disclose a plasma for removing etch residue that consists of ammonia or consists of hydrogen, likewise Smith does not disclose such a plasma that consists of methane gas, as recited in the claim. Thus, for the same reasoning set forth above for the patentability of claims 1 and 54 over Smith, independent claim 70 and dependent claims 72, 73, and 82 are likewise patentable

thereover. Applicants respectfully request that the 35 U.S.C. § 102(e) rejection of claims 70-73 and 82 be withdrawn.

Claims 6-13, 16-18, 21-24, 27, 28, 58-65, 74-81, and 86-88 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Smith. Applicants respectfully traverse this rejection.

Claims 6-13 depend from claim 1, which has been discussed above as being patentable over Smith. Likewise and for at least the same reasoning, dependent claims 6-13 are patentable over this reference. Applicant respectfully requests that the 35 U.S.C. § 103(a) rejection of claims 6-13 be withdrawn.

Claim 16, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, “contacting said opening with a plasma consisting of oxygen to remove a portion of said etch residue, stopping said oxygen plasma contacting before said polymer etch residue is completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma, said second plasma consisting of a hydrogen containing gas.” Such a method as claimed is not taught or suggested by Smith.

The same disclosure of steps 304 and 313 of Smith, as discussed above, are applicable to claim 16. Smith does not teach or suggest removing polymer etch residue by first using a plasma consisting of oxygen to remove some, but not all of the etch residue followed by using a plasma consisting of a hydrogen containing gas to completely remove any remaining residue. Such partial removal with oxygen plasma and complete removal with hydrogen containing plasma is simply not disclosed anywhere in Smith, thus the subject matter of claim 16 would not have been obvious in view of Smith. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 16-18, 21-24, 27, 28, and 86-88 be withdrawn.

Claims 58-65 depend from claim 54 which has been discussed above as being patentable over Smith. Likewise and for at least the same reasoning, dependent claims 58-65 are patentable over this reference. Applicant respectfully requests that the 35 U.S.C. § 103(a) rejection of claims 58-65 be withdrawn.

Claims 74-81 depend from claim 70, which has been discussed above as being patentable over Smith. Likewise and for at least the same reasoning, dependent claims 74-81 are patentable over this reference. Applicant respectfully requests that the 35 U.S.C. § 103(a) rejection of claims 74-81 be withdrawn.

Claims 29-31, 34-38, 41-44, and 89-91 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,284,664 (Kawai) and Smith. Applicants respectfully traverse this rejection.

Claim 29, as amended, defines a method of forming a contact opening in a semiconductor device and recites, in part, “contacting said opening with an oxygen plasma to remove a portion of said etch residue” and “removing any remaining etch residue from said etched opening by contacting said opening with a plasma consisting of a hydrogen containing gas in the absence of added oxygen.” Although the claim language differs somewhat from that of claim 16, claim 29 is patentable over Smith for the same reasons set forth above for the patentability of claim 16. Additionally, Kawai does not teach or suggest removal of a portion of etch residue with an oxygen plasma followed by removal of any remaining residue with a plasma consisting of a hydrogen containing gas in the absence of oxygen. This combination of steps is simply not taught or suggested by either of Smith or Kawai and would not have been obvious over these references taken individually or in combination. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 29-31, 34-38, 41-44, and 89-91 be withdrawn.

Claims 1, 2, 15, 25, 26, 39, 50-53, 67-69, 83-85, and 92-97 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kawai, Smith, and U.S. Patent

6,291,890 (Hamada). Applicants respectfully traverse this rejection.

Claim 1 has been discussed as being patentable over Smith individually. Kawai and Hamada, individually or in combination, can add nothing to supplement Smith so as to have rendered the subject matter of claim 1 obvious. Specifically, like Smith, neither Kawai nor Hamada teaches or suggests removal of etch residue by contacting an opening with a plasma generated from a gas consisting of ammonia. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 1, 2, and 15 be withdrawn.

Claims 25-39 depend from claim 16, which has been discussed above as patentable over Smith. Like Smith, neither Kawai nor Hamada teaches or suggests contacting an opening with a plasma consisting of oxygen to remove a portion of said etch residue, stopping said oxygen plasma contacting before said polymer etch residue is completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma, said second plasma consisting of a hydrogen containing gas. Thus, the disclosure of Smith cannot be supplemented by Kawai and Hamada so as to have rendered the subject matter of claim 16 obvious. Applicants respectfully requests that the 35 U.S.C. § 103(a) rejection of claims 25, 26, and 39 be withdrawn.

Claim 50, as amended, defines a method of forming an integrated circuit structure and recites, in part, “removing polymer residue from said contact opening using a plasma consisting of ammonia gas which provides an oxide free bottom of said contact opening, and which does not substantially increase size of said opening.” Although claim 50 includes additional limitations not recited by claim 1, it does recite that polymer residue is removed by a “plasma consisting of ammonia gas,” which is not taught or suggested by any of Smith, Kawai, and Hamada, taken individually or in combination. Thus, like claim 1, the subject matter of claim 50 would not have been obvious over these references. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 50-53 be withdrawn.

Claims 67-69 depend from claim 54, which has been discussed above as being patentable over Smith. Kawai and Hamada cannot supplement the disclosure of Smith so as to have rendered the subject matter of claim 54 obvious. Specifically, neither of these additional references teaches or suggests “contacting said opening with a plasma to remove said polymer etch residue; said plasma generated from a gas consisting of hydrogen gas.” Since all the elements of claim 54 are not taught or suggested by the cited references, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 67-69 be withdrawn.

Claims 83-85 depend from claim 70, which has been discussed above as being patentable over Smith. Neither Kawai nor Hamada teaches or suggests the subject matter of claim 70 which is not taught or suggested by Smith. Specifically, these references do not teach or suggest “contacting said opening with a plasma to remove said polymer etch residue; said plasma generated from a gas consisting of methane gas.” Thus, dependent claims 83-85 are patentable over these references, taken individually or in combination. Applicant respectfully requests that the 35 U.S.C. § 103(a) rejection of claims 83-85 be withdrawn.

Claim 92, as amended, defines a method of forming an integrated circuit structure and recites, in part, “removing polymer residue from said contact opening using a plasma consisting of hydrogen gas which provides an oxide free bottom of said contact opening, and which does not substantially increase size of said opening.” Although claim 50 includes additional limitations not recited by claim 54, it does recite that polymer residue is removed by a “plasma consisting of hydrogen gas,” which is not taught or suggested by any of Smith, Kawai, and Hamada, taken individually or in combination. Thus, like claim 54, the subject matter of claim 92 would not have been obvious over these references. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 92-94 be withdrawn.

Claim 95, as amended, defines a method of forming an integrated circuit